NON-PUBLIC?: N
ACCESSION #: 9206240286
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Pilgrim Nuclear Power Station PAGE: 1 OF 10

DOCKET NUMBER: 05000293

TITLE: Automatic Scram Resulting from a Turbine Runback due to Failure of Potential Transformer and Voltage Balance Relay Wiring Error
EVENT DATE: 08/30/89 LER #: 89-026-01 REPORT DATE: 06/11/92

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 065

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: Douglas W. Ellis - Senior TELEPHONE: (508) 747-8160
Compliance Engineer

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: EL COMPONENT: XMFR MANUFACTURER: W120
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On August 30, 1989 at 1917 hours, an automatic Reactor Protection System (RPS) scram signal and reactor scram occurred while at 65 percent reactor power. As expected, the scram signal resulted in an automatic sequence of designed responses that included a Turbine-Generator trip, automatic opening of two 345KV switchyard air circuit breakers, and an automatic transfer of station electrical loads.

The direct cause of the scram signal was high Reactor Vessel/Main Steam System pressure of 1069 psig that occurred as a result of an automatic Turbine runback. The Turbine runback was caused by the failure of a nonsafety-related 24KV potential transformer (PT) in conjunction with a nonsafety-related voltage balance relay wired in accordance with an approved architect-engineer (Bechtel) drawing that contained an error since original construction (c. 1971). The PT was manufactured by the Westinghouse Electric Corporation, style EED2553, serial number 70F3376. The cause of the PT failure was a manufacturing defect consisting of a large void within the PT potting (insulating) compound. The PT was replaced, the drawing error was corrected, and the voltage balance relay was rewired in accordance with the revised drawing. The procedure used to functionally test the voltage balance relay was strengthened. Applicable portions of the station electrical system were tested and/or evaluated for impact of overvoltage with satisfactory results.

This event occurred with the reactor mode selector switch in the RUN position. The initial Reactor Vessel pressure was 9
0 psig. This report
is submitted in accordance with 10 CFR 50.73(a)(2)(iv). This event posed no threat to the public health and safety.

END OF ABSTRACT

REASON FOR SUPPLEMENT

This report is submitted to meet our commitment to supplement the initial report.

EVENT DESCRIPTION

On August 30, 1989 at approximately 1917 hours, an automatic Reactor Protection System (RPS) scram signal and reactor scram occurred while at 65 percent reactor power. As expected, the scram signal resulted in an automatic sequence of designed responses that included a Turbine-Generator trip. The Turbine trip included the following responses:

o Automatic closing of the Main Steam System/Turbine Valves (stop valves, control valves, combined intermediate valves). The Turbine Bypass Valves, initially in the open position, subsequently closed as the Main Steam System pressure decreased.

o Automatic opening of the Generator Field Breaker. The Generator trip was the designed response to the loss of field resulting from the opening of the field breaker.

o Automatic transfer of the source of power for the Auxiliary

Power Distribution System (APDS) from the Unit Auxiliary Transformer to the Startup Transformer.

o Automatic opening of the 345 KV switchyard air circuit breakers ACB-104 (352-4) and ACB-105 (352-5).

As expected, the Reactor Vessel (RV) water level decreased in response to the scram because of a decrease in the void fraction in the RV water. The RV water level eventually decreased to approximately -32 inches. The decreased RV water level, to less than the low RV water level setpoint (calibrated at approximately inches), resulted in the following expected designed responses:

o Automatic actuation of the Reactor Building Isolation Control System (RBIS). The actuation resulted in the automatic closing of the Reactor Building/Secondary Containment System (SCS) supply and exhaust ventilation dampers (Trains 'A' and 'B'), and the automatic start of Trains 'A' and 'B' of the SCS/Standby Gas Treatment System (SGTS).

o Automatic actuation of appropriate portions of the Primary Containment Isolation Control System (PCIS). The actuation resulted in the following responses:

o Automatic closing of the inboard and outboard Primary Containment System (PCS)/Reactor Water Sample isolation valves.

o The inboard and outboard PCS Group 2 (two)/Sample System isolation valves, in the closed position, remained closed.

o The PCS Group 3 (three)/Residual Heat Removal System isolation valves, in the closed position, remained closed.

o Automatic closing of the inboard and outboard PCS Group 6 (six)/Reactor Water Cleanup (RWCU) System isolation valves and a temporary interruption in RWCU System operation.

Initial Control Room operator response was orderly and included the following activities. The process of verifying the insertion of the control rods began in accordance with procedure 2.1.6, "Reactor Scram". Emergency Operating Procedure EOP-01, "RPV Control", was initiated at approximately 1918 hours when the Reactor Vessel (RPV) water decreased to inches and was terminated at approximately 1922 hours when the Reactor Vessel water level increased to inches. At 1924 hours, the RPS circuitry was reset in accordance with procedure 2.1.6. At 1925 hours, the RBIS circuitry was reset. The Reactor Building/SCS supply and exhaust ventilation dampers were reopened and the SGTS was returned to normal standby service. At 1927 hours, the PCIS circuitry was reset and the RWCU System was returned to service at 1928 hours. At 1937 hours, procedure 2.1.7, "RPV Temperature and Pressure Check List", was initiated. At 1956 hours, procedure 2.1.5 section B, "Operation After Reactor Scram with MSIVs Open", was initiated. At 2027 hours, ACBs 104 and 105 were reclosed.

Failure and Malfunction Report 89-327 was written to document the event. The NRC Operations Center was notified in accordance with 10 CFR 50.72 on August 30, 1989 at 2020 hours. A post trip review of the event was conducted in accordance with procedure 1.3.37, "Post Trip Reviews".

BACKGROUND

The Main Generator voltage regulator functions to control the generator's output voltage (24KV nominal) that is supplied to the primary windings of the Main Transformer and the Unit Auxiliary Transformer (UAT). The generator's output system is equipped with instrumentation for metering and relaying. Included in the instrumentation are six potential transformers (PTs) with two PTs connected to each of the output system's three 24KV phases. Each PT has a primary and secondary winding, with a separate fuse for each winding. Essentially, a PT's primary winding is connected to a 24KV phase and the secondary winding is connected to instrumentation. The instrumentation includes the Main Generator voltage regulator and voltage balance relay 260. The voltage balance relay, General Electric type CFVB, is a protective type relay that functions to block the incorrect operation of an electrical device if a PT fuse blows.

Voltage balance relay 260 is associated with the 345 KV transmission system's distance relay 221 and the Main Generator voltage regulator transfer relay 83. The voltage balance relay is connected to two auxiliary relays, 260X1 and 260X2. The 260X1 relay provides a distance relay 221 blocking function if a related PT fuse blows and a corresponding alarm function at Panel C-3R, "Generator Potential Fuse Blown". The 260X2 relay provides a voltage regulator transfer function, from automatic to manual via transfer relay 83, if a related PT fuse blows and it also provides a corresponding alarm function to the same alarm window at Panel C-3R, "Generator Potential Fuse Blown".

The Main Generator voltage regulator transfer function is accomplished manually or automatically via transfer relay 83. A manual transfer to the manual control mode is accomplished by moving the voltage regulator transfer switch to the MANUAL position from the AUTO position. While the transfer switch is in the AUTO position, the voltage regulator is in the automatic control mode and is automatically transferred to the manual control mode if any one of the following four conditions occur: a blown PT fuse, detected by the voltage balance relay; Generator excitation limit for 10 seconds, detected by relay J3K; Generator exciter field overcurrent, detected by devices 76/501X and 2X!; or, Generator field breaker open, detected by devices 41M/POS and 41E/AUX. Subsequent investigation after the event indicates the transfer was automatic and was most likely initiated by relay J3K.

Prior to the event, steady state operating conditions existed and included the following. The reactor mode selector switch was in the RUN position and the reactor power level was 75 percent. The Reactor Vessel (RV) pressure was approximately 980 psig and the RV water temperature was approximately 520 degrees Fahrenheit. The RV water level was inches and was being controlled automatically in the three element control mode.

The Recirculation System pumps were being controlled in the local manual control mode. The Condensate System and Feedwater System pumps were all in service. The Control Rod Drive System pump 'A' was in service. The APDS was energized by the Main Generator output system via the 4160 VAC secondary windings of the Unit Auxiliary Transformer. The Main Generator voltage regulator was in the automatic control mode with its transfer switch in the AUTO position. The RPS motor generator sets 'A' and 'B' were in service providing 120 VAC to the respective Panel C-511 buses 'A' and 'B'. The 120 VAC standby Electrical Protection Assemblies EPA-5 and EPA-6 were in standby service and were energized via the standby RPS transformer X-20.

Just prior to the event, on August 30, 1989 at approximately 1916 hours, several Main Control Room alarms occurred in a short interval of time. The alarms included: Panel C-3R, "Generator Potential Fuse Blown", "Stator Cooling Low Inlet Flow", "Exciter Field Ground", "Generator Field Ground", and Panel C-2L, "Turbine Runback". The accompanying automatic Turbine runback included an automatic adjustment of the four Main Steam System/Turbine Control Valves, and the sequential opening of the three Main Steam System/Turbine Bypass Valves. Meanwhile, and in accordance with the Alarm Response Procedure ARP-C2L for a Turbine runback, the utility licensed reactor operator began to reduce the reactor power level in accordance with procedure 2.1.14 (Rev. 14), "Station Power Changes". The RV/Main Steam System pressure began a gradual increase in response to the Turbine runback and reached the high RV pressure scram setpoint approximately 50 seconds after the Turbine runback began.

The shift Nuclear Operating Supervisor's (NOS) initial response to the Turbine runback alarm was to verify the controlled reduction in reactor power was proceeding in accordance with procedure 2.1.14. Subsequently, the NOS proceeded to the Electrical Control Panel C-3 and noticed the Main Generator voltage regulator raise-lower voltmeter was indicating full deflection in the "raise" direction. Accordingly, the NOS (utility licensed operator) moved the voltage regulator transfer switch to the MANUAL position. After the event, investigation revealed the NOS moved the transfer switch just after the automatic transfer. The automatic transfer resulted in a decrease in the Main Generator's output. Based on data obtained from the regional power authority (REMVEC), the Main Generator output voltage had increased from an initial nominal value of approximately 24,350 VAC to a calculated maximum value of 27,794 VAC. The duration of the voltage transient, from nominal to maximum and return to nominal, was approximately 40 seconds.

CAUSE

The direct cause for the scram signal was a momentary high RV pressure condition. Though short in duration (approximately five seconds), the pressure of approximately 1069 psig was slightly above the RPS high RV pressure scram setpoint (calibrated at approximately 1065 psig). The gradual increase in RV pressure was an expected response to an automatic Turbine runback at 75 percent reactor power.

The Turbine runback was the designed response to the comparative mismatch in the Main Generator current and stator cooling water flow. The mismatch was caused by the increase in the generator current that occurred as a result of the failure of the primary winding of the 24 KV phase 'A' PT and an electrical drawing E47 error that consequently affected the voltage regulator trans
er function.

Voltage balance relay 260 was wired in accordance with the approved electrical drawing E47. However, the drawing incorrectly (i.e., oppositely) identified the terminal designations connecting the voltage balance relay to the coils of auxiliary relays 260X1 and 260X2. Because of the drawing error, the coil of auxiliary relay 260X1 was connected to the voltage balance relay terminal number 18 instead of terminal number

13, and the coil of auxiliary relay 260X2 was connected to terminal number 13 instead of terminal number 18. The drawing error existed since original construction (c. 1971). Apparently, the architect-engineer (Bechtel) designer for drawing E47 incorrectly translated the termination numbers from the voltage balance relay manufacturer's instruction manual, General Electric GEI-31030C Figure 5, to the drawing.

The actuation of either auxiliary relay 260X1 or 260X2 causes the same alarm at Panel C-3R window F-3 to annunciate. The nonsafety-related voltage balance relay is functionally tested in accordance with procedure 3.M.3-39, "Turbine/Generator Calibration of Relays, Lockout Test and Associated Annunciator Verification". The drawing error was not previously detected because procedure 3.M.3-39, although demonstrating the voltage balance relay functions and alarm functions, did not include a step to identify the specific auxiliary relay (260X1 or 260X2) that actuated and resulted in the alarms during the test.

For this event, the actuation of the voltage balance relay should have resulted in the actuation of auxiliary relay 260X2 and an automatic transfer of the Main Generator voltage regulator to the manual control mode via the transfer relay 83. Because of the reversed wiring of auxiliary relays 260X1 and 260X2, transfer relay 83 did not actuate and the voltage regulator remained in the automatic control mode. Concurrently, the failure of the PT (primary winding) caused the voltage regulator circuitry to falsely sense a decrease in the Main Generator output voltage. Consequently, the voltage regulator automatically increased the generator output voltage and corresponding current. The increased current resulted in a comparative mismatch (i.e. greater than

15 percent) in the Main Generator current and the generator stator cooling water flow. The mismatch resulted in the automatic Turbine runback and related alarms, "Turbine Runback", and, "Stator Cooling Low Inlet Flow".

The Panel C-3R, "Generator Potential Fuse Blown", "Exciter Field Ground", and, "Generator Field Ground", alarms were the result of the failure of the 24KV primary winding of the PT connected to the Main Generator output system phase 'A'. The failure of the primary winding caused its related fuse to blow and actuated the voltage balance relay.

The cause for the PT failure was a manufacturing defect. The defect consisted of a large void within the PT potting (insulating) compound. The PT is a sealed and welded assembly. The fault was located via infrared microscanner while applying approximately 10 VAC to the low voltage winding X1-X3 with the brown H2 high voltage bushing grounded, the PT case grounded, and the white HI high voltage bushing ungrounded. The potting compound, though very viscous, was solidified by packing the PT case in dry ice and the casing sides were later removed. The removal revealed a large void in the potting compound next to the white H1 bushing, and extended under the bottom of the bushing. This void location was adjacent to a port apparently used to add the compound to the casing. The nature and location of the void suggested the PT was not completely filled to the proper level with potting compound during the manufacturing process. A small amount of ash resulting from the failure was discovered in the bottom of the void. After reaching room temperature, the low voltage winding was again energized to approximately 10 "C. At that voltage, electrical discharges were observed coming from the white HI bushing at the void. As the voltage was increased, the discharges tracked to the top of the PT case and flashed over. The test evidence indicates the PT failure was not due to aging but rather, a manufacturing defect. The large void next to and at the bottom of the white bushing allowed the high voltage to eventually track to the grounded PT case.

The failed PT was manufactured by the Westinghouse Electric Corporation, style EED2253, serial number 70F3376, primary voltage 14400/24940Y, ratio (H1-H2/X1-X3) 120:1, 25KV rated insulation class.

CORRECTIVE ACTION

The following corrective actions have been taken:

o Drawing E47 was revised (to Rev. E8) after verifying that the drawing was incorrect. The drawing change was accomplished via a corrective action program document (PCAQ 89-84).

o The voltage balance relay wiring to auxiliary relays 260X1 and 260X2 was reversed after the wiring diagram was changed. The wiring change was implemented as a modification (FRN 89-02-23).

o Procedure 3.M.3-39 (formerly Rev. 6), "Turbine/Generator Calibration of Relays, Lockout Test and Associated Annunciator Verification", was revised. Essentially, the procedure was revised to identify the specific auxiliary relay, 260X1 or 260X2, that actuates during a functional test of the voltage balance relay and the related alarm "Generator PT Fuse Blown". The revision similarly strengthened other portions of the procedure regarding functional tests of the "Generator Field Overvolt", and, "Voltage Regulator Trip", alarms.

o The failed PT and its related blown primary fuse were replaced.

Prior to installation, the new PT was tested (insulation resistance, polarity, and ratio) with satisfactory results. The replacement was completed on September 2, 1989.

o Voltage balance relay 260 and auxiliary relays 260X1 and 260X2 and alarms were functionally tested with satisfactory results on September 4, 1989. The test was performed via the revised procedure 3.M.3-39 and was completed on September 4, 1989.

o The windings of the Main Generator field and exciter field were tested (resistance and polarization index) with satisfactory results. The testing was completed on September 3, 1989.

o The Main Transformer was power factor tested with satisfactory results. The testing was completed on September 3, 1989.

o Oil samples obtained from the Main Transformer and Unit Auxiliary Transformer after the event were analyzed with satisfactory results. The results for each transformer compared favorably with previous analyses performed and indicated the transformers were not adversely affected as a result of the event.

o The 4160 VAC motor of the Control Rod Drive (CRD) System pump P-209A, in service at the time of the event, was polarization index tested with satisfactory results. The test was completed on September 2, 1989. The test provided assurance the 4160 VAC motors in service at the time of the event were not adversely affected as a result of the event.

o The 480 VAC motors of two Closed Cooling Water System pumps, one safety-related (P-202A) and one nonsafety-related (P-110B), in service at the time of the event were polarization index tested. The test was performed with satisfactory results via procedure 3.M.3-4 (Rev. 4) Attachments AA, "480V Non-safety Related Loads & Cables", and BB, "480 Safety Related Loads & Cables". The testing was completed on September 2, 1989 (P-202A) and September 4, 1989 (P-110B). The testing provided assurance 480 VAC motors in service at the time of the event were not adversely affected as a result of the event.

At Pilgrim Station, there are two other applications of voltage balance relays in addition to the Main Generator output system. The instrumentation for the output system of each of the two Emergency Diesel Generators includes a voltage balance relay and related PTs. Each of the two voltage balance relays, 160-509 and 160-609, separately provides a blocking function and alarm function if a related PT fuse blows. The drawings (wiring, schematic, and functional control) for these voltage balance relays were reviewed to ensure the applications of the relays are consistent and agree with the applications described in the manufacturer's manual (i.e. vendor manual V-0358). The review was performed with satisfactory results.

The unit returned to commercial service on September 7, 1989 at 1015 hours. The Main Generator core monitor was continuously monitored with satisfactory results when the Main Generator field was initially flashed and during the subsequent power increase.

PREVENTIVE ACTION

The other 24KV PTs are currently scheduled for inspection during the next midcycle outage (MCO 92). The purpose of the inspection is to determine if the PTs are the same style, age, and construction as the failed PT. If the PTs are the same as the failed PT, the PTs will be subjected to a Power Factor test on the high voltage windings.

SAFETY CONSEQUENCES

This event posed no threat to the public health and safety.

The scram signal was the designed response to the high RV/Main Steam System pressure that occurred as a result of the Turbine runback. The Turbine trip and Generator trip were the expected designed responses to the scram signal.

The Technical Specification 2.2 limiting safety system settings for the Main Steam System relief valves and safety valves are 1115 psig 11 psig and 1240 psig 13 psig, respectively. During the event the highest RV/Main Steam System pressure of approximately 1069 psig was below those settings.

The decrease in the RV water level was the expected response to the scram and accompanying shrink in the RV water. The PCIS and RBIS actuations were the expected designed responses to a low RV water level condition, i.e. inches.

The Technical Specification 2.1.I limiting safety system setting for actuation of the Core Standby Cooling Systems (CSCS) is -49 inches. During the event the lowest Reactor Vessel water level of approximately -32 inches was approximately 14 inches above the CSCS setpoint (calibrated at approximately -46 inches). The level of -32 inches was approximately 95.5 inches above the level corresponding to the top of the active fuel zone (approximately -127.5 inches).

A Nuclear Engineering Department (NED) evaluation of the voltage transient concluded the station electrical system was not adversely affected. The evaluation was based on considerations including the following:

o Recent calibration data of the 120 VAC standby Electrical Protection Assemblies EPA-5 and EPA-6 that were energized and did not trip.

o The results of the electrical tests of the Main Generator field and Exciter field, Main Transformer and Unit Auxiliary Transformer.

o The results of analyses of the oil samples taken from the Main Transformer and Unit Auxiliary Transformer.

o The excitation characteristic curves of the Unit Auxiliary

Transformer and Standby RPS Transformer.

o The results of the electric tests performed on selected motors including the 4160 VAC motor of CRD pump P-209A and 480 VAC motors of the Reactor Building Closed Cooling Water System pump P-202A and Turbine Building Closed Cooling Water System pump P-110B that were energized at the time of the event.

o The results of voltage calculations for the 24 KV and 480 VAC buses.

o The duration and magnitude of the voltage transient.

o The hi-pot testing of the 4160 VAC buses at 19 KVAC for one minute (phase-to-adjacent phase, phase-to-ground) as part of the manufacturing process.

o The hi-pot testing of 4160 VAC breaker insulation at 14 KVAC for one minute as part of the manufacturing process.

o The characteristics of the Pilgrim Station electrical system.

This report is submitted in accordance with 10 CFR 50.73(a)(2)(iv) because the RPS was actuated.

SIMILARITY TO PREVIOUS EVENTS

A review was conducted of Pilgrim Station Licensee Event Reports (LERs) submitted since January 1984. The review focused on LERs involving an actuation of the RPS due to a Turbine runback, or involving the failure of a potential transformer. The review identified no previous events.

ENERGY INDUSTRY IDENTIFICATION SYSTEM (EIIS) CODES

The EIIS codes for this report are as follows:

COMPONENTS CODES

Circuit Breaker, AC 52
Motor MO
Potential Device (PT) FD
Relay, Blocking (260X1 and 260X2) 68
Relay, Voltage Balance 60
Transformer (PT) XMFR

SYSTEMS

Containment Isolation Control System (PCIS,RBIS) JM
Control Rod Drive System AA
Engineered Safety Features Actuation System
(RPS,PCIS,RBIS) JE
Low-Voltage Power System (480 VAC) - Class 1E ED
Main Generator System TB
Main Generator Output Power System EL
Main Steam System SB
Main Turbine System TA
Medium-Voltage Power System (4160 VAC) - Class 1E EB
Plant Protection System (RPS) JC

Reactor Building (SCS) NG
Reactor Water Cleanup (RWCU) System CE
Standby Gas Treatment System (SGTS) BH
Station Generation Telemetering System FJ
Switchyard System (345 KV) FK
Uninterruptible Power System (120 VAC)-Class 1E EF

ATTACHMENT 1 TO 9206240286 PAGE 1 OF 1

10 CFR 50.73

BOSTON EDISON
Pilgrim Nuclear Power Station
Rocky Hill Road
Plymouth, Massachusetts 02360

Roy A. Anderson
Senior Vice President - Nuclear

June 11, 1992
BECo Ltr. 92-061

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Docket No. 50-293
License No. DPR-35

Dear Sir:

The enclosed supplemental Licensee Event Report (LER) 89-026-01, "Automatic Scram Resulting from a Turbine Runback due to Failure of Potential Transformer and Voltage Balance Relay Wiring Error" is submitted in accordance with 10 CFR Part 50.73.

Please do not hesitate to contact me if there are any questions regarding this report.

R. A. Anderson

DWE/bal

Enclosure: LER 89-026-01

cc: Mr. Thomas T. Martin
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Rd.
King of Prussia, PA 19406

Sr. NRC Resident Inspector - Pilgrim Station

Standard BECo LER Distribution

*** END OF DOCUMENT ***